

Flood inundation possibility analysis system using GIS

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Research Background and Purpose

Research Background

- The localized downpour occurrence possibility increase by recent heavy rainfall
- In the case of large scale plain, local inundation possibility existence by drain badness
- Insufficiency of surface water storage and flow analysis linked storm sewer system
- Necessary of Prompt analysis and Measure plan of inundation area that is expected by localized downpour

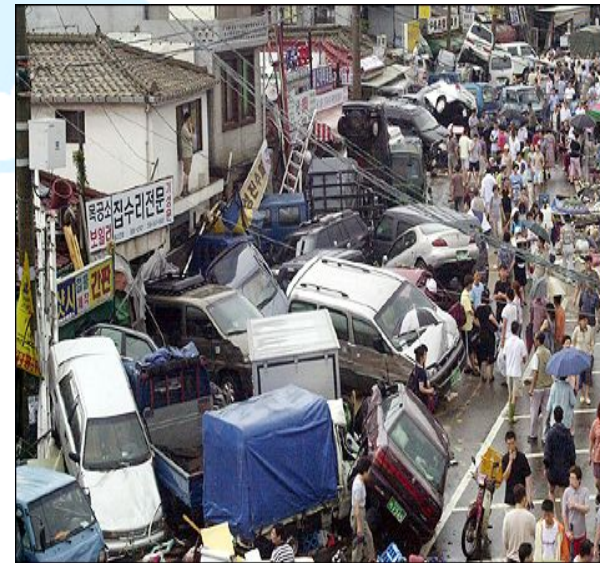
Research Purpose

- Development of integrated inundation analysis model that can simulate together surface water and storm sewer using GIS
- Flood inundation damage possibility examination of urban areas drainage system
- When execute flood inundation analysis model, offer user's convenience by develop and present pre-post process using GIS.



Example study of flood inundation damage in the city

- Internal inundation cause Estimation and countermeasure establishment at Seoksu 2dong in Anyang city
- Inundation possibility analysis and countermeasure establishment services of the Incheon international airport
- Estimation of inundation cause and countermeasure establishment at NO. 7Line of subway around express bus terminal



Flood inundation damage cause in the city(I)

Flood inundation damage cause in the city

- Concentration rainfall in excess of storm sewer network design rainfall
- Residence form with semi-underground form

- Drop inlet establishment regulation unsuitableness and management insufficiency
- Occurrence of local surcharge flow

Street inlet establishment regulation
Unsuitableness and management insufficiency

- ✓ Limitation of Only if storm drainage on the road
- ✓ Conveyance deterioration due to maintenance management carelessness
- ✓ hydraulic consideration insufficiency for drop inlet and sewer

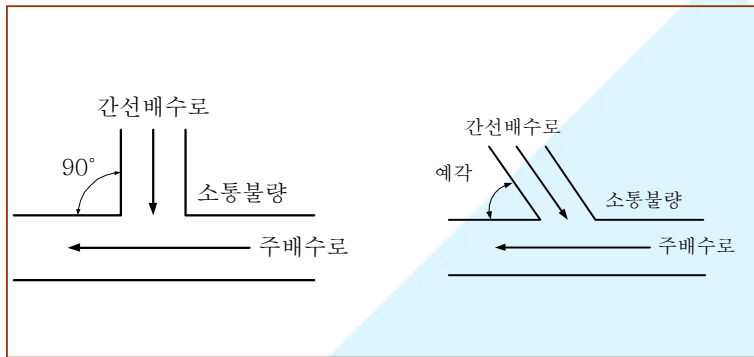
Occurrence of local surcharge flow

- ✓ Coneying flow disturbance in confluence of sewer
- ✓ Occurrence of head loss in sewer manhole
- ✓ Occurrence of head loss in a steep slope point of sewer

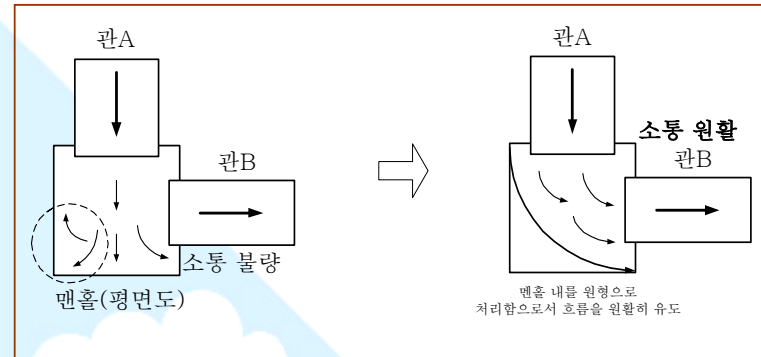


Flood inundation damage cause in the city(II)

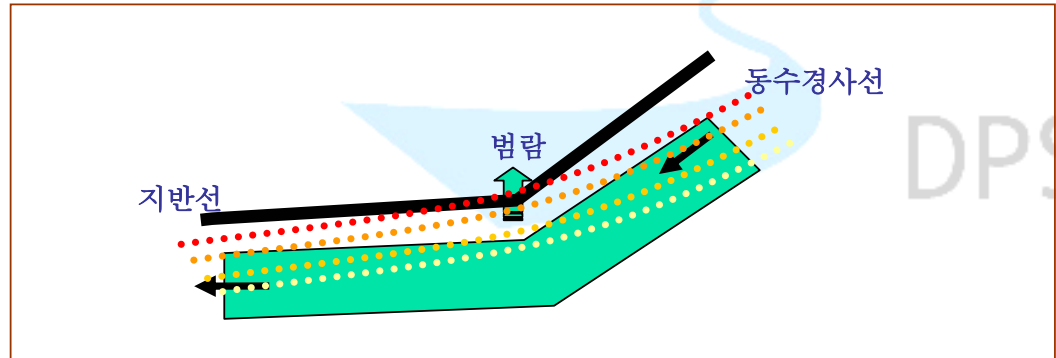
Obstacle at confluence point



Loss head occurrence in manhole

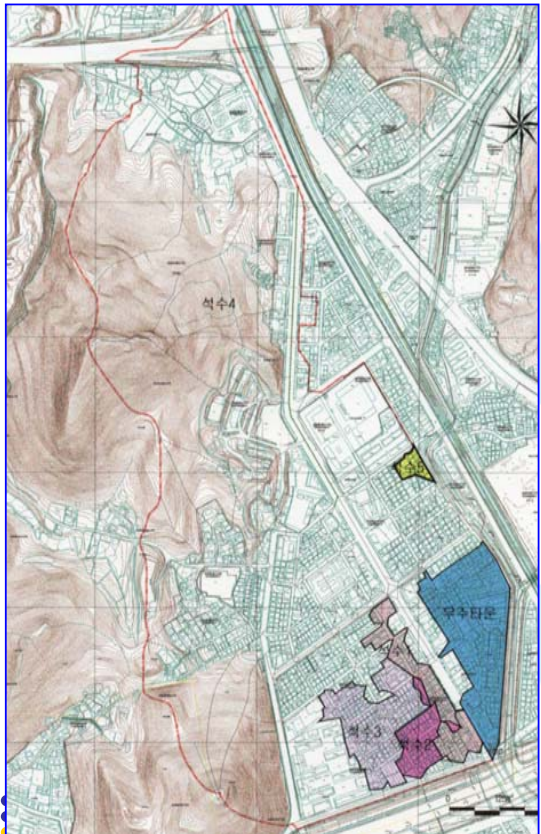


Loss head occurrence at steep slope point

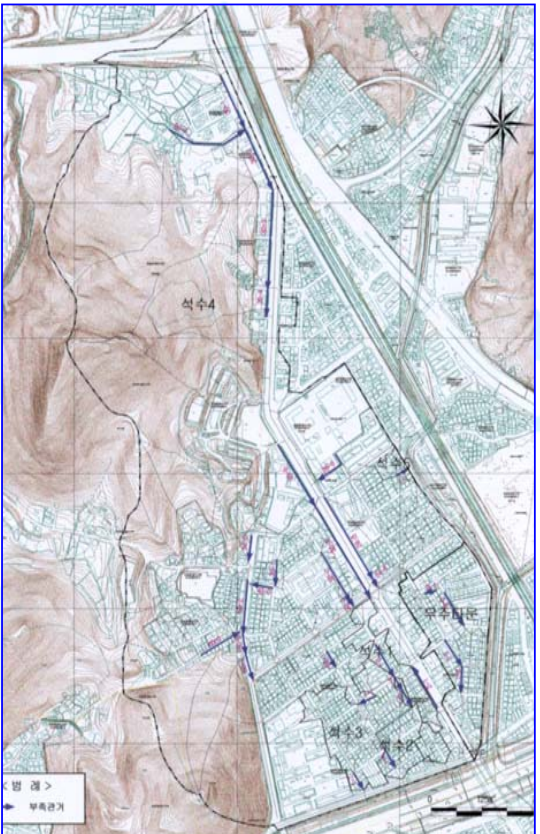


Flood inundation in the city- Research basin

Drainage basin map



Pipe network map

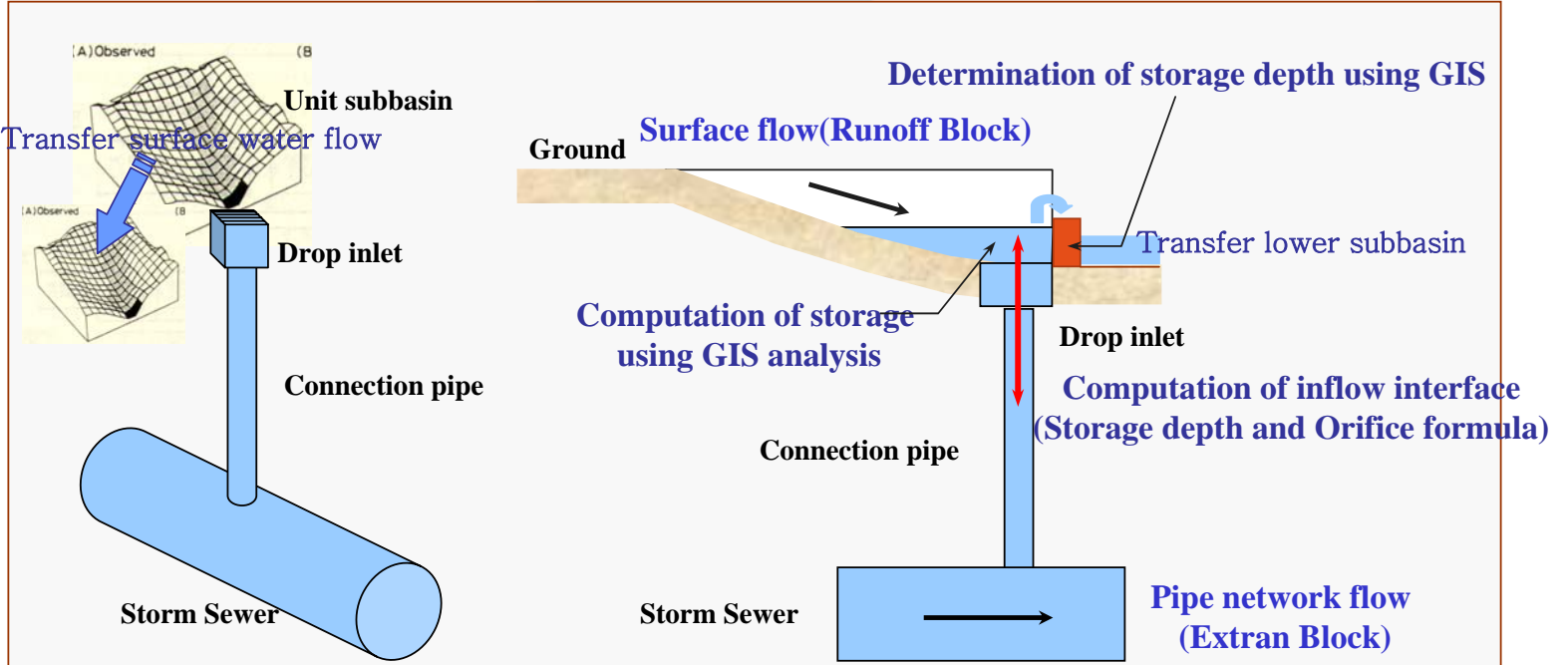


Surface flow route map



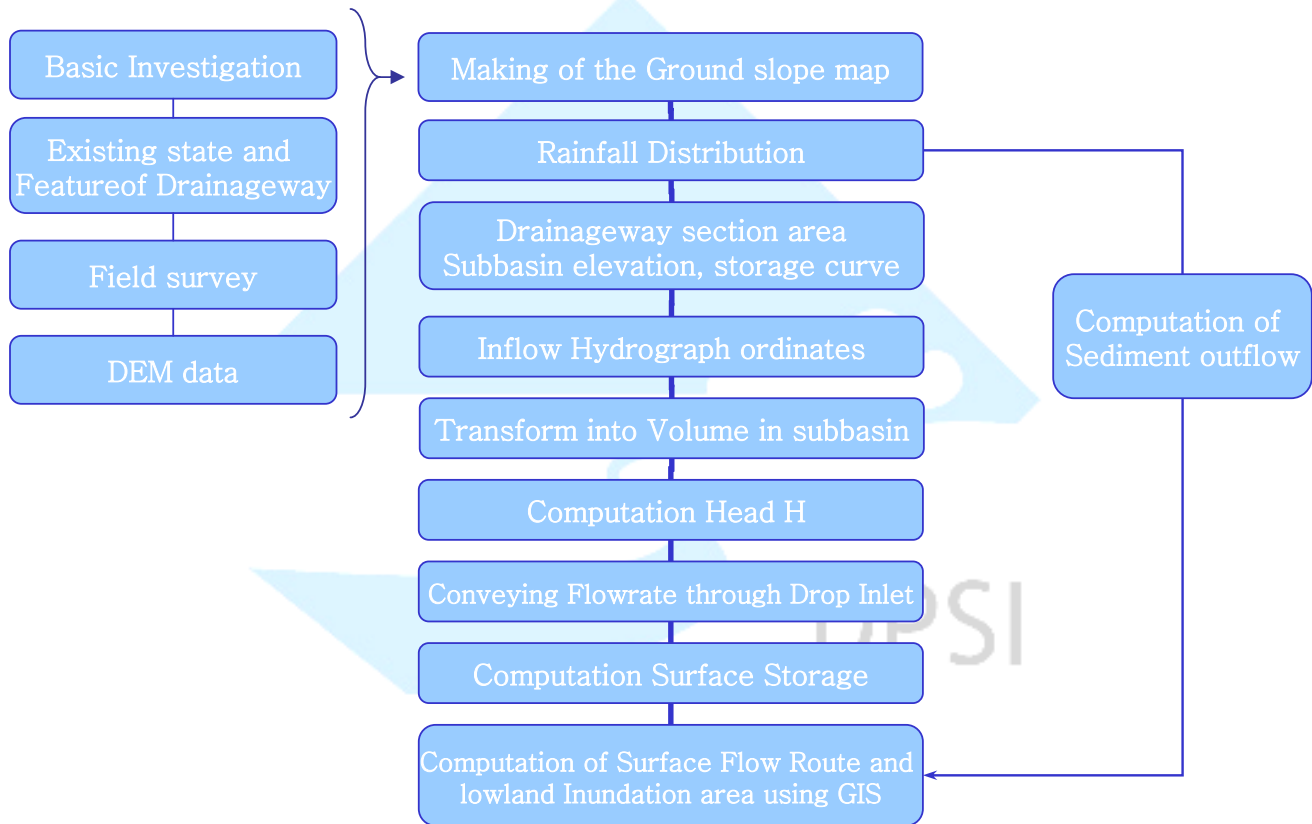
Flood inundation in the city- Model development

- The need for application of the dynamic model
 - ▶ Application of the RUNOFF and EXTRAN (SWMM)
- Quantification for surface storage in subbasin
 - ▶ Determination of surface storage using GIS
- Modeling of the drop inlet and connection pipe
 - ▶ Modeling of the orifice type drop inlet and connection pipe

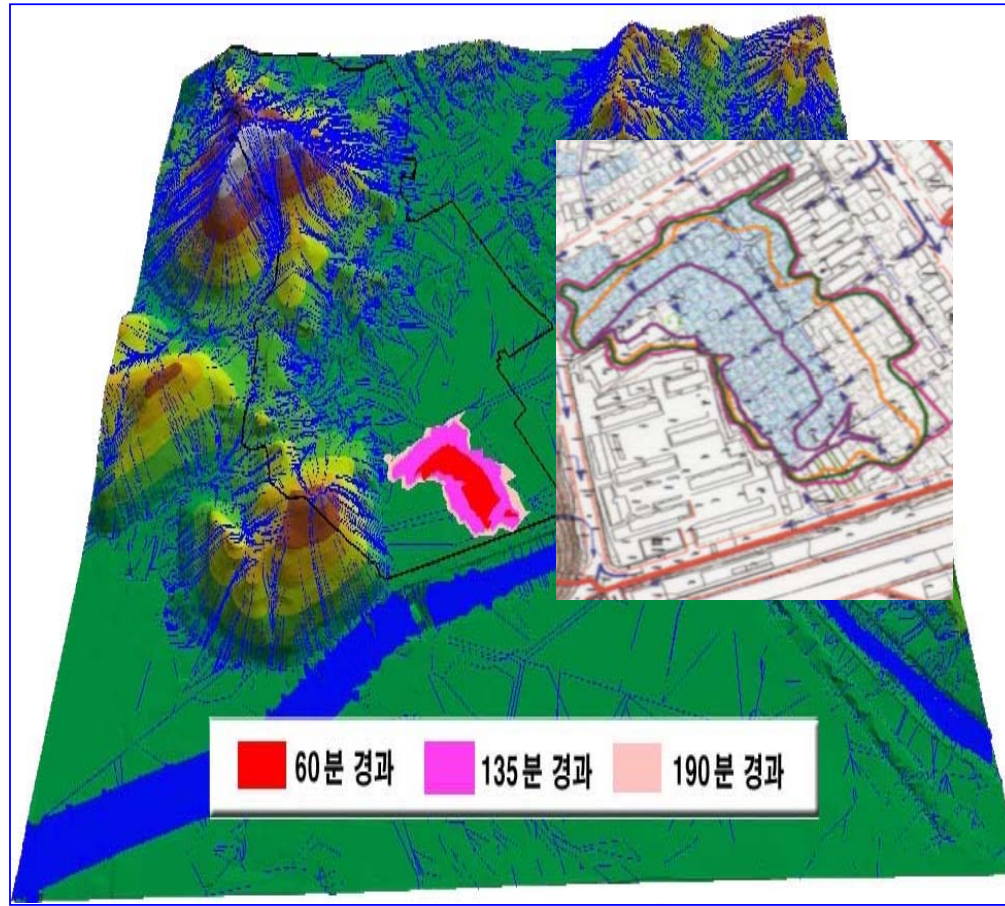


Flood inundation in the city- Analysis process

Analysis process



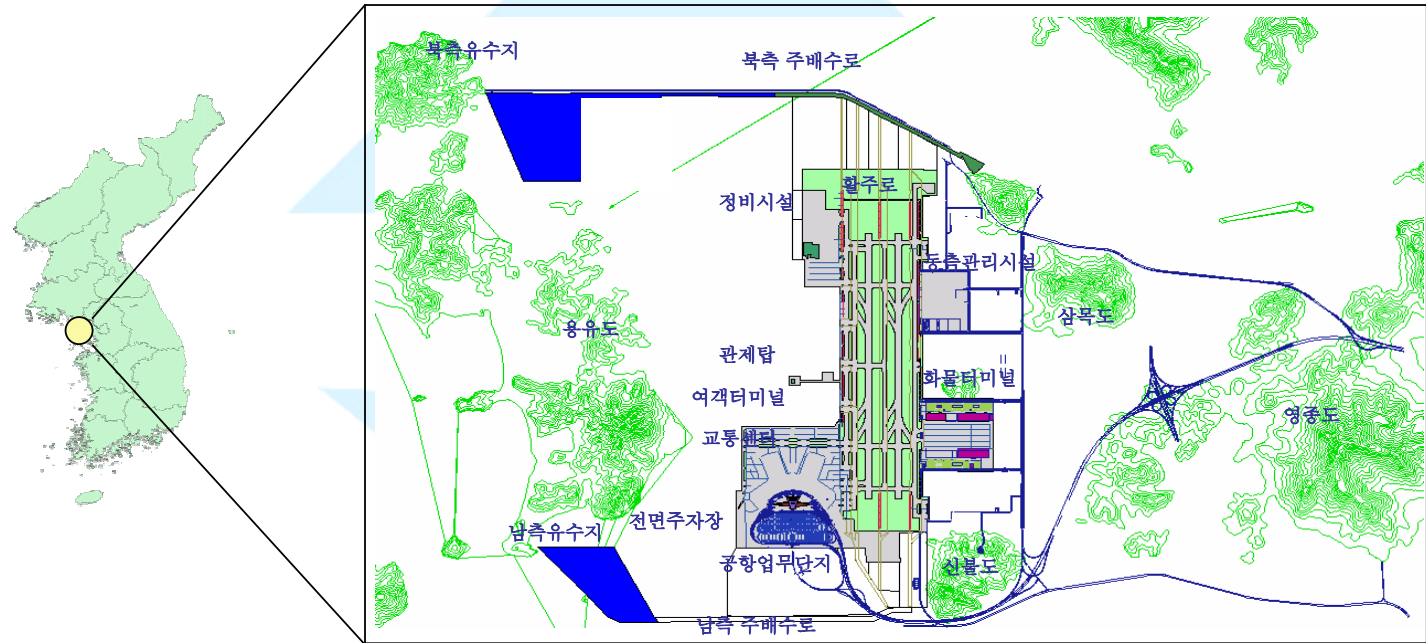
Flood inundation in the city- Application result



Flood inundation flood (Inchon international airport) – Research basin

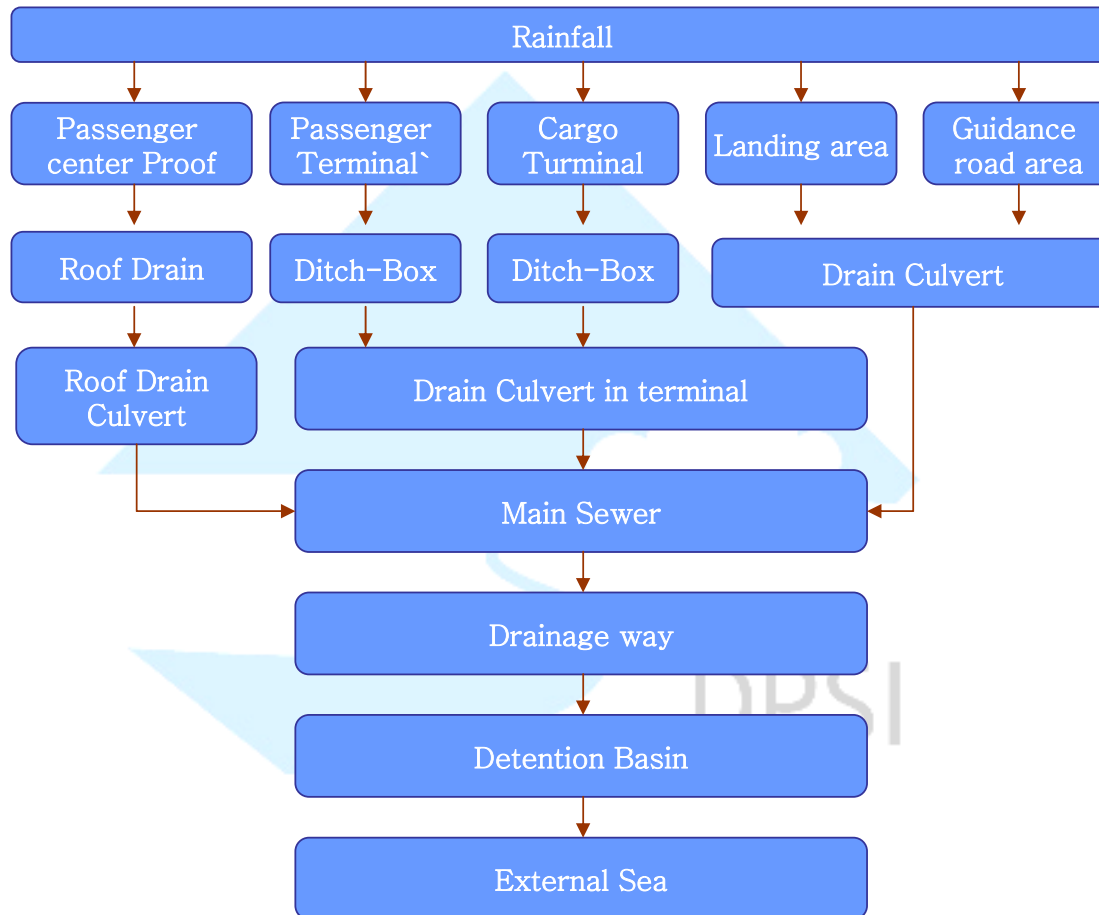
Study interest area

- Insurance of security in Incheon national airport carrying out a pivotal faculty of air transfortation In 21 century
- Existence of local inundation possibility due to drainage disturbance



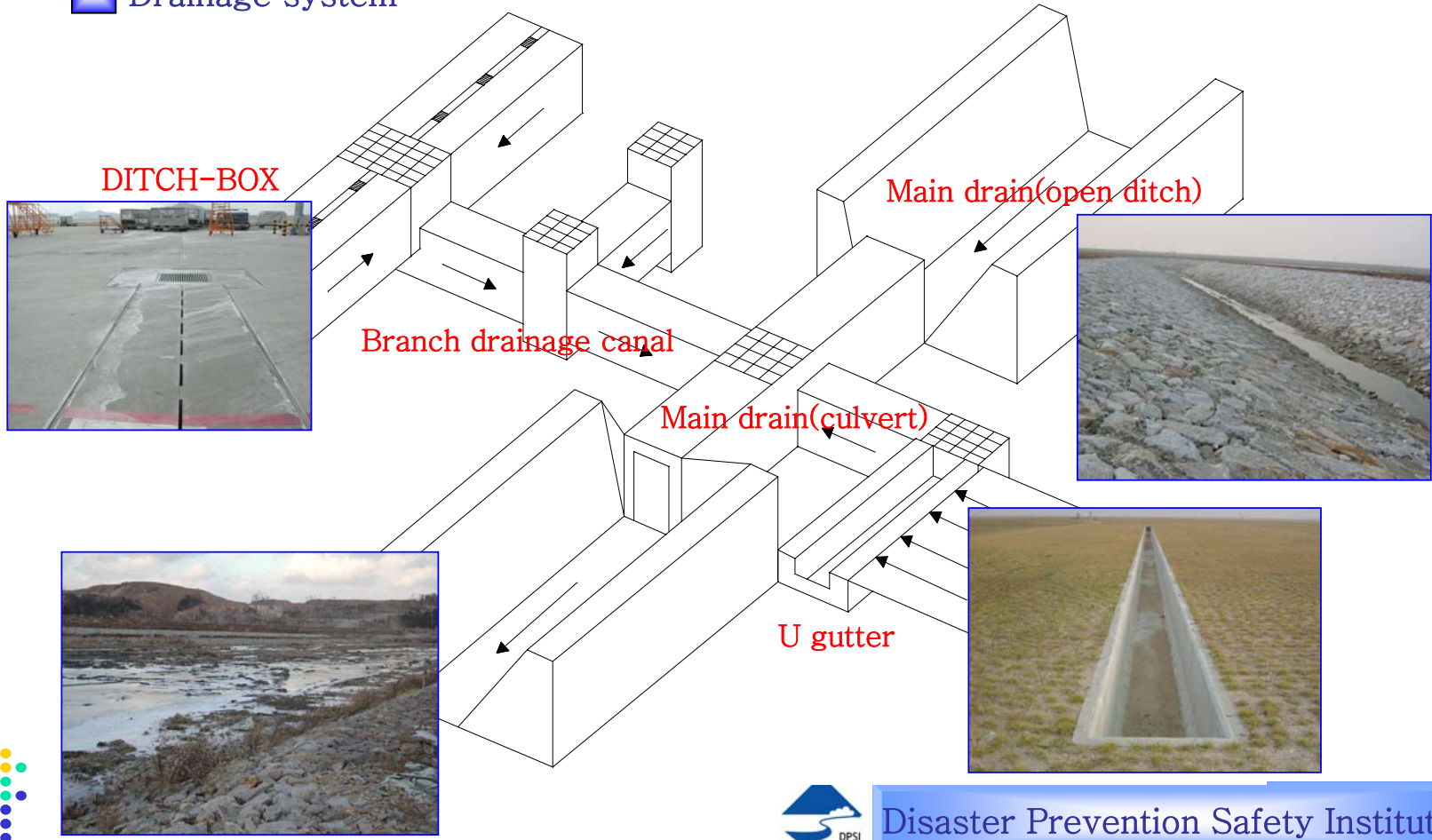
Flood inundation (Inchon international airport)-Drainage system(I)

Flowchart of flood inundation analysis model



Flood inundation (Inchon international airport)-Drainage system(II)

Drainage system



Flood inundation flood (Inchon international airport) - model development(I)

Defect of existing model

Defect of existing surface water analysis model

- friction slope and basin slope are same
- If Backwater is high, inappropriateness
- Analysis by simple time of concentration and variable of distance
- Quantitative analysis about inundation phenomenon is insufficiency

Defect of existing sewer channel analysis model

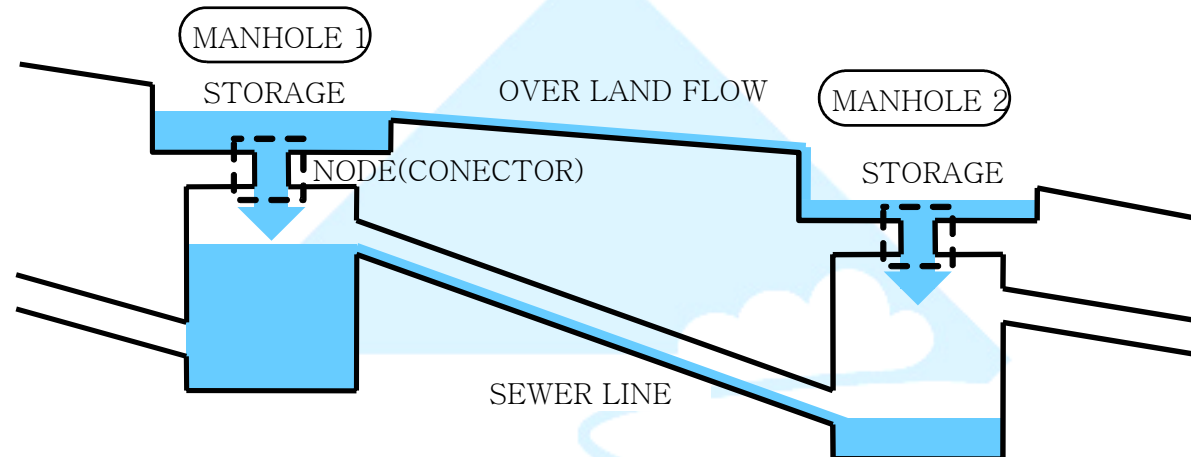
- Complicated drain system processing insufficiency
- In case producing concentration rainfall, reappearance of surcharge flow phenomenon is insufficiency
- Link conduct analysis insufficiency with surface water and storm sewer
- Analysis insufficiency for synthetic flowing system of road surface and drain pipe channel

Improvement of analysis model and construction of integration model of surface water-storm sewer



Flood inundation flood (Inchon international airport) - Model development(II)

Integration flood inundation analysis model development of surface water-sewer channel

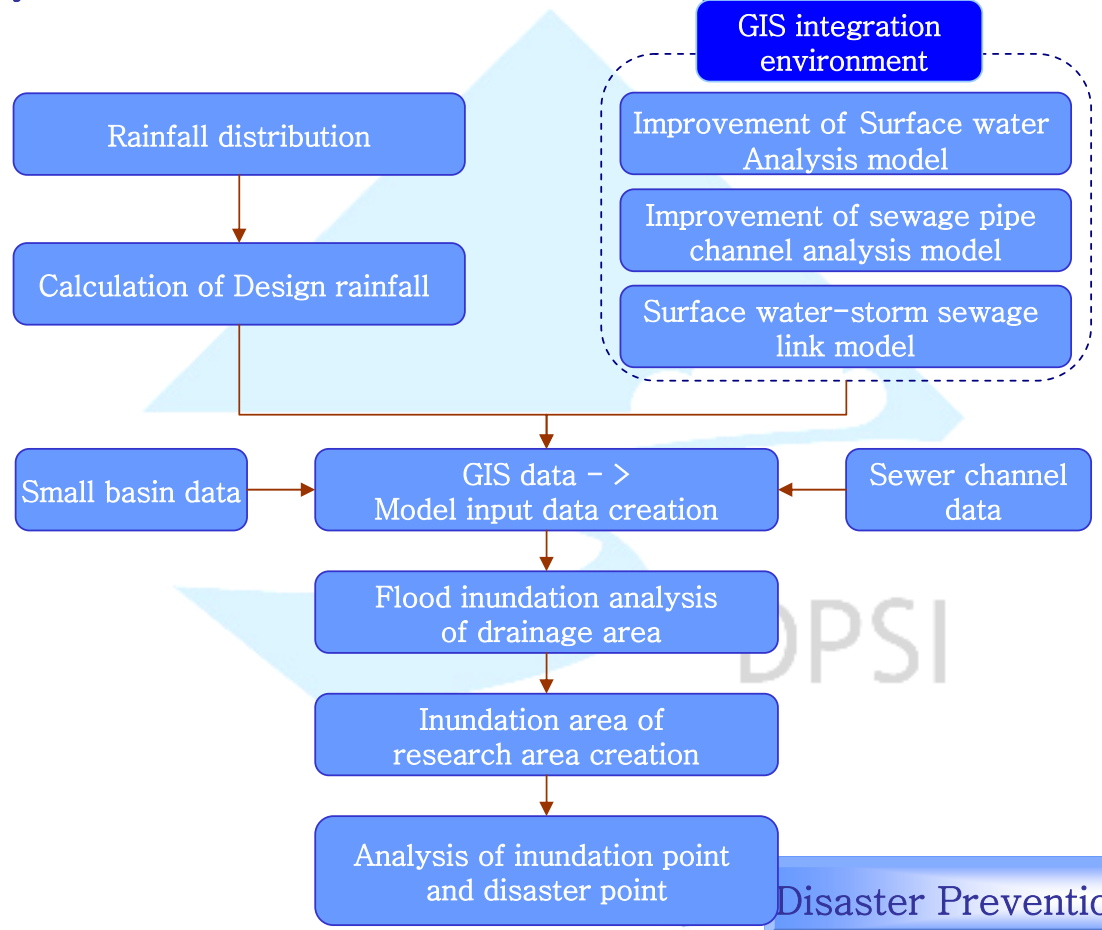


- Water of surface water system is inflow by sewer channel system through connector of manhole
- Surface water that is not flowed in drainpipe system becomes surface of the earth undercurrent or flowing to lower class basin
- Because drainpipe is packed, Surge flow is occurrence
- In case produce concentration rainfall, phenomenon examination that rainwater is not drained by inset defect



Flood inundation flood (Inchon international airport) - Analysis process

Analysis flowchart of flood inundation analysis model

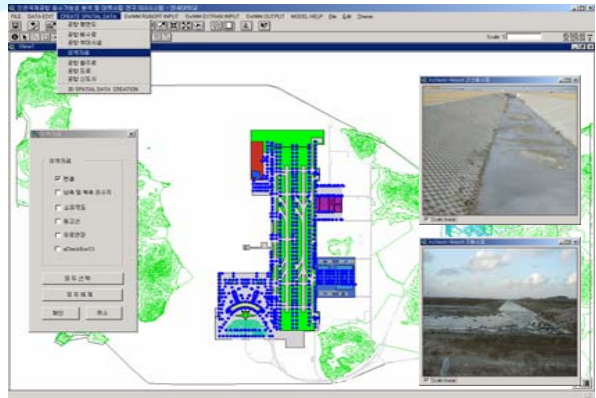
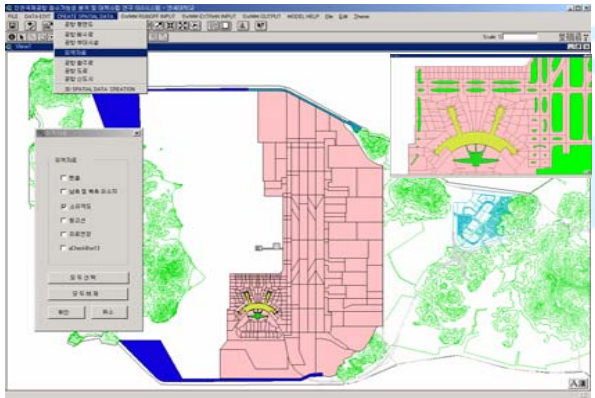


Flood inundation flood (Inchon international airport) - D/B Construction

GIS Database Construction

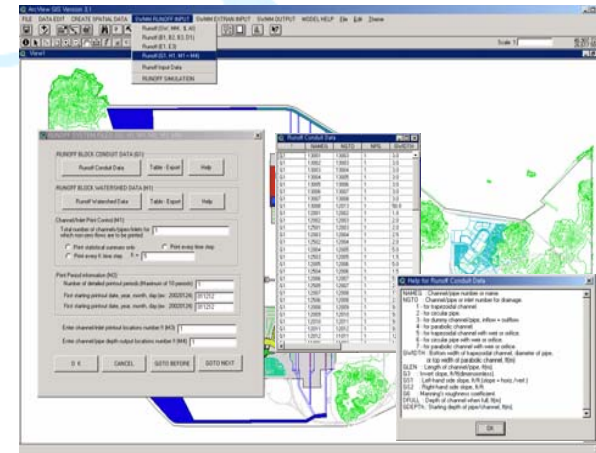
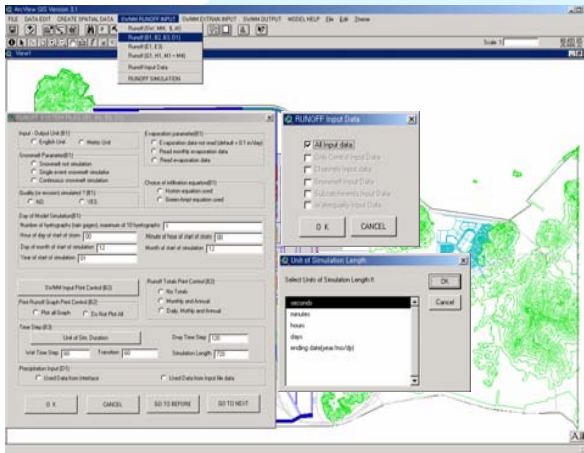
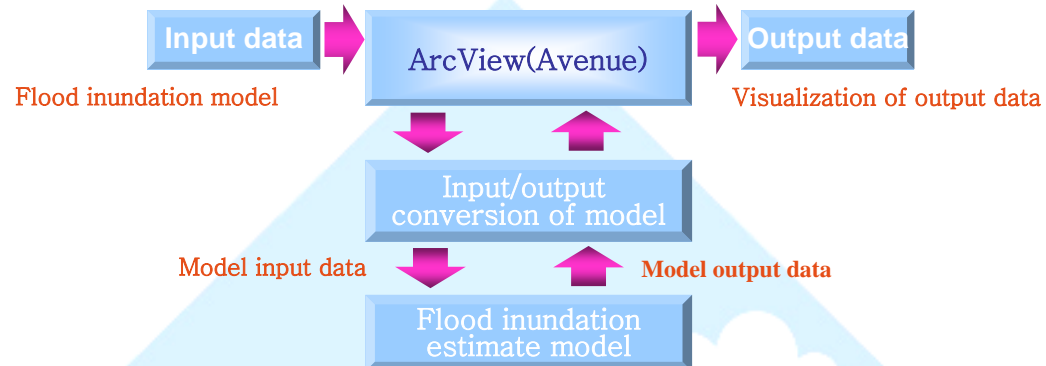
Manage of systematic airport facilities and Offer by means for objective decision-making

Division		GIS D/B
1	Building	Passenger terminal, traffic center, freight terminal, control tower, support equipment etc.
2	Drain system	Manhole, U type gutter, branch channel, main channel, reservoir etc..
3	Small basin data	Small basin (348), contour line, picture data etc..
4	Runway	Pervious and Impervious area



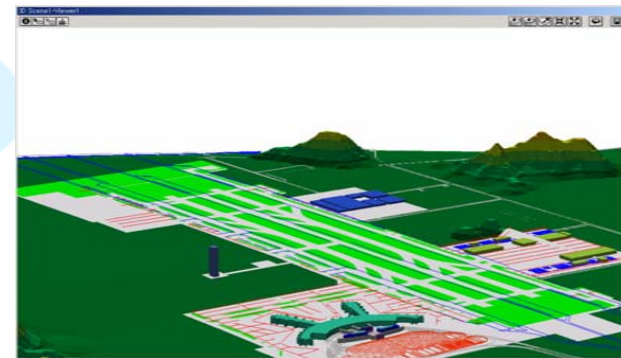
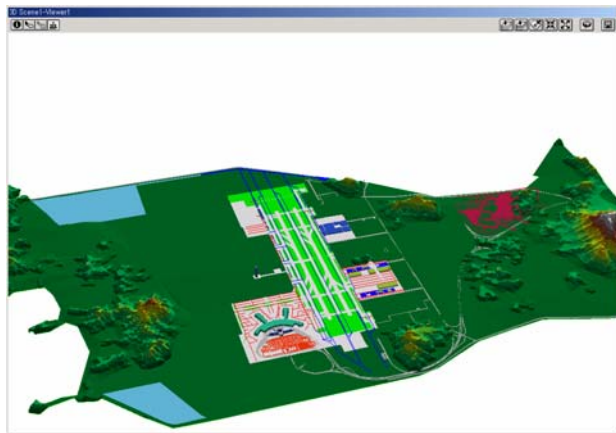
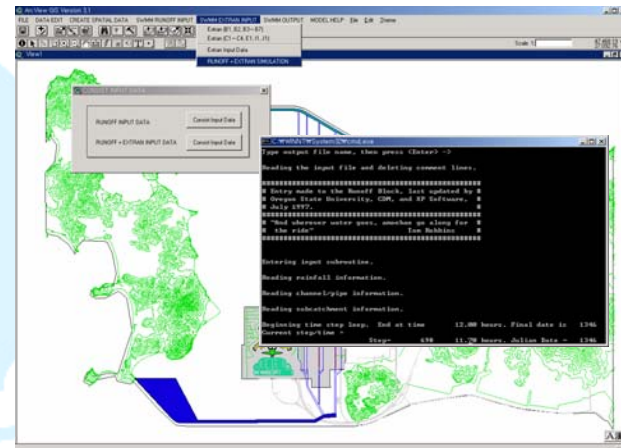
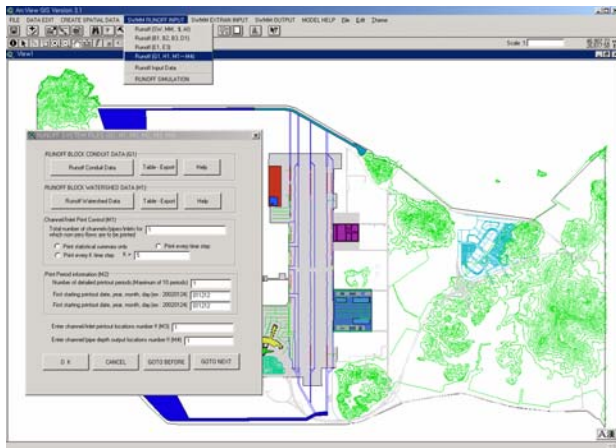
Flood inundation flood (Inchon International Airport) – System construction (I)

Desing of GIS/flood inundation analysis system



Flood inundation flood (Inchon International Airport) – System construction (II)

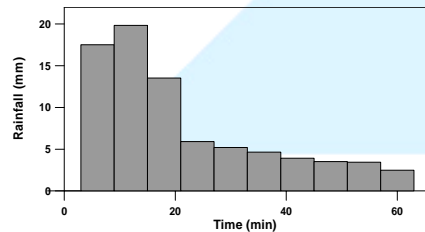
Construction of flood inundation analysis system



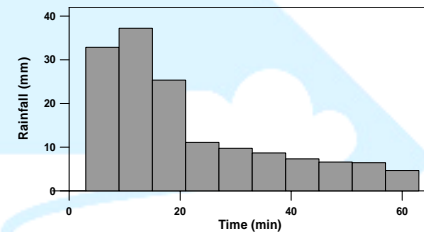
Flood inundation flood (Inchon international airport) – System application (I)

Calculation condition for dynamic inundation analysis

- To divide small basin (348) considering position of inset (435) and pipe channel (437)
- 360 rainfall application(10 ~120 minutes,10~300mm)
 - ▶ Choice of Huff 1 st
 - ▶ Application of the recent rainfall that is irregular space/time distribution



Huff 1분위 강우 80mm, 지속시간 60분



Huff 1분위 강우 150mm, 지속시간 60분

Analysis result

- Inundation occurrence possibility point arrangement from 360 rainfall
 - ▶ Analysis of Inundation point (more than that is 1cm) of whole airport facilities
 - ▶ Inundation form analysis of airport facilities
 - ▶ Priority consideration area choice that consider importance (function of airport) of facilities



Flood inundation flood (Inchon international airport) – System application (II)

Number (more than that is 1cm) of inundation occurrence possibility point basin

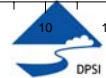
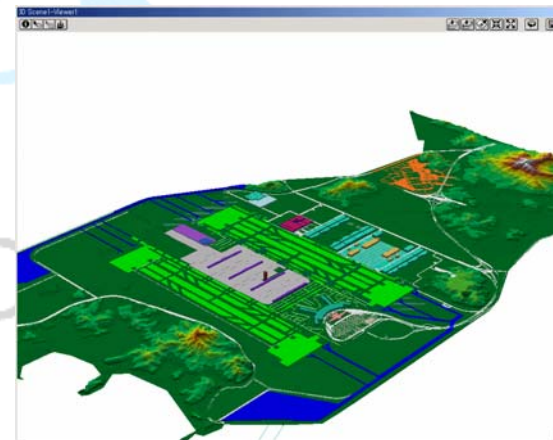
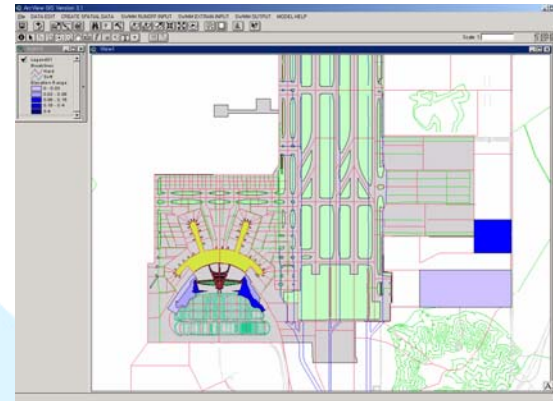
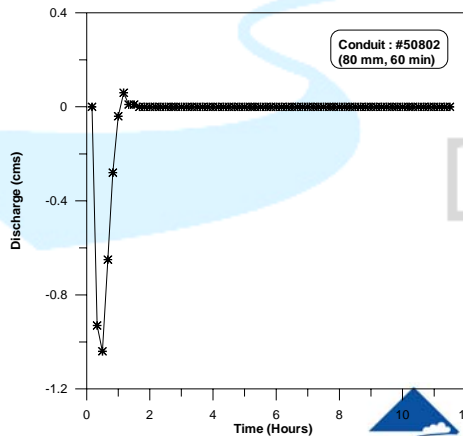
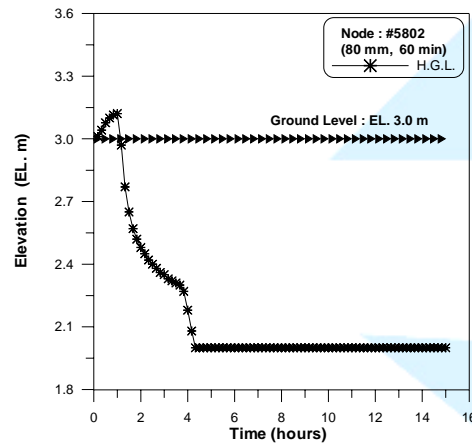
rainfall	duration 10min	duration 20min	Duration 30min	duration 40min	duration 50min	duration 60min	duration 70min	duration 80min	duration 90min	duration 100min	duration 110min	duration 120min
10mm	0(60.0)	0(30.0)	0(20.0)	0(15.0)	0(12.0)	0(10.0)	0(8.6)	0(7.5)	0(6.7)	0(6.0)	0(5.5)	0(5.0)
20mm	0(120.0)	0(60.0)	0(40.0)	0(30.0)	0(24.0)	0(20.0)	0(17.1)	0(15.0)	0(13.3)	0(12.0)	0(10.9)	0(10.0)
30mm	3(180.0)	3(90.0)	2(60.0)	2(45.0)	2(36.0)	1(30.0)	0(25.7)	0(22.5)	0(20.0)	1(18.0)	0(16.4)	0(15.0)
40mm	6(240.0)	4(120.0)	4(80.0)	3(60.0)	2(48.0)	2(40.0)	2(34.3)	2(30.0)	2(26.7)	2(24.0)	2(21.8)	2(20.0)
50mm	6(300.0)	6(150.0)	4(100.0)	4(75.0)	4(60.0)	3(50.0)	3(42.9)	2(37.5)	2(33.3)	2(30.0)	6(27.3)	2(25.0)
60mm	6(360.0)	6(180.0)	4(120.0)	4(90.0)	4(72.0)	4(60.0)	4(51.4)	4(45.0)	3(40.0)	4(36.0)	3(32.7)	2(30.0)
70mm	(420.0)	6(210.0)	6(140.0)	6(105.0)	6(84.0)	4(70.0)	4(60.0)	4(52.5)	4(46.7)	4(42.0)	4(38.2)	4(35.0)
80mm	(480.0)	6(240.0)	6(160.0)	6(120.0)	6(96.0)	4(80.0)	4(68.6)	4(60.0)	4(53.3)	4(48.0)	4(43.6)	4(40.0)
90mm	(540.0)	8(270.0)	6(180.0)	6(135.0)	6(108.0)	6(90.0)	6(77.1)	6(67.5)	4(60.0)	4(54.0)	4(49.1)	4(45.0)
100mm	(600.0)	11(300.0)	8(200.0)	6(150.0)	6(120.0)	6(100.0)	6(85.7)	6(75.0)	6(66.7)	6(60.0)	4(54.5)	4(50.0)
110mm	(660.0)	15(330.0)	9(220.0)	9(165.0)	6(132.0)	6(110.0)	6(94.3)	6(82.5)	6(73.3)	6(66.0)	6(60.0)	5(55.0)
120mm	(720.0)	26(360.0)	12(240.0)	10(180.0)	8(144.0)	6(120.0)	6(102.9)	6(90.0)	6(80.0)	6(72.0)	6(65.5)	6(60.0)
130mm	(780.0)	35(390.0)	17(260.0)	11(195.0)	10(156.0)	7(130.0)	7(111.4)	6(97.5)	6(86.7)	6(78.0)	6(70.9)	6(65.0)
140mm	(840.0)	(420.0)	21(280.0)	17(210.0)	14(168.0)	10(140.0)	10(120.0)	7(105.0)	6(93.3)	6(84.0)	6(76.4)	6(70.0)
150mm	(900.0)	(450.0)	21(300.0)	20(225.0)	16(180.0)	13(150.0)	10(128.6)	9(112.5)	7(100.0)	6(90.0)	6(81.8)	6(75.0)
160mm	(960.0)	(480.0)	35(320.0)	29(240.0)	30(192.0)	20(160.0)	14(137.1)	13(120.0)	13(106.7)	13(96.0)	12(87.3)	12(80.0)
170mm	(1020.0)	(510.0)	48(340.0)	32(255.0)	35(204.0)	29(170.0)	20(145.7)	14(127.5)	14(113.3)	13(102.0)	13(92.7)	12(85.0)
180mm	(1080.0)	(540.0)	60(360.0)	38(270.0)	43(216.0)	35(180.0)	28(154.3)	17(135.0)	18(120.0)	15(108.0)	14(98.2)	13(90.0)
190mm	(1140.0)	(570.0)	72(380.0)	39(285.0)	46(228.0)	36(190.0)	32(162.9)	24(142.5)	21(126.7)	16(114.0)	15(103.6)	13(95.0)
200mm	(1200.0)	(600.0)	82(400.0)	45(300.0)	51(240.0)	39(200.0)	34(171.4)	27(150.0)	26(133.3)	22(120.0)	16(109.1)	16(100.0)
210mm	(1260.0)	(630.0)	(420.0)	48(315.0)	57(252.0)	45(210.0)	37(180.0)	32(157.5)	27(140.0)	27(126.0)	22(114.5)	19(105.0)
220mm	(1320.0)	(660.0)	(440.0)	55(330.0)	60(264.0)	50(220.0)	41(188.6)	36(165.0)	31(146.7)	32(132.0)	25(120.0)	23(110.0)
230mm	(1380.0)	(690.0)	(460.0)	57(345.0)	68(276.0)	54(230.0)	45(197.1)	42(172.5)	35(153.3)	34(138.0)	27(125.5)	25(115.0)
240mm	(1440.0)	(720.0)	(480.0)	64(360.0)	71(288.0)	62(240.0)	51(205.7)	44(180.0)	37(160.0)	36(144.0)	34(130.9)	27(120.0)
250mm	(1500.0)	(750.0)	(500.0)	64(375.0)	78(300.0)	68(250.0)	56(214.3)	49(187.5)	43(166.7)	37(150.0)	34(136.4)	30(125.0)
260mm	(1560.0)	(780.0)	(520.0)	71(390.0)	85(312.0)	75(260.0)	60(222.9)	53(195.0)	48(173.3)	43(156.0)	36(141.8)	35(130.0)
270mm	(1620.0)	(810.0)	(540.0)	(405.0)	90(324.0)	79(270.0)	63(231.4)	58(202.5)	53(180.0)	49(162.0)	37(147.3)	36(135.0)
280mm	(1680.0)	(840.0)	(560.0)	(420.0)	97(336.0)	79(280.0)	68(240.0)	62(210.0)	54(186.7)	54(168.0)	46(152.7)	41(140.0)
290mm	(1740.0)	(870.0)	(580.0)	(435.0)	101(348.0)	86(290.0)	76(248.6)	64(217.5)	57(193.3)	56(174.0)	50(158.2)	42(145.0)
300mm	(1800.0)	(900.0)	(600.0)	(450.0)	107(360.0)	93(300.0)	83(257.1)	69(225.0)	59(200.0)	61(180.0)	53(163.6)	48(150.0)



Flood inundation flood (Inchon international airport) – System application (III)

The east of traffic center

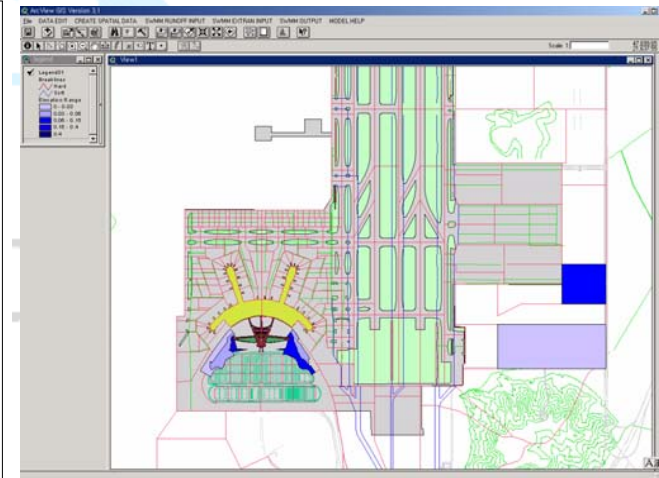
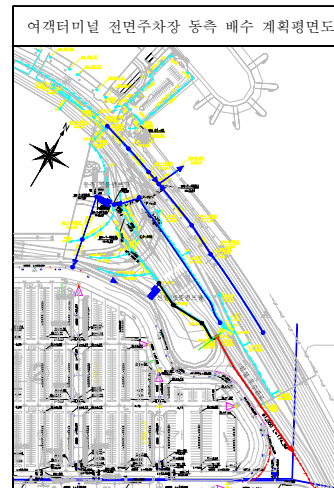
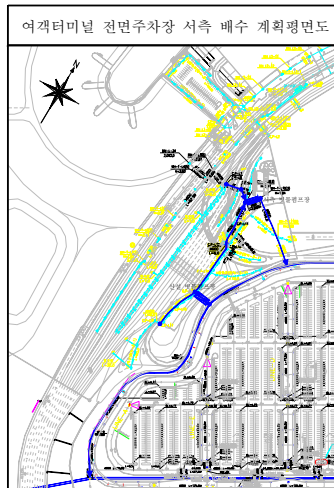
- ▶ Defect occurrence of partial drain system of branch channel
- ▶ Inundation occurrence of manhole that is backwater effect by pressure flow



Flood inundation flood (Inchon international airport) – System application (IV)

Result of flood inundation of existing facilities (frequency 20 years : 76.3mm, 60 min)

Facilities	Result	Inundation depth		Inundation time		Inundation point		Note
		east	west	east	west	east	west	
Traffic center	<ul style="list-style-type: none"> Existing facilities (Establishment of east and west existing pump station) 	12.9 cm	33.6 cm	10mi n ~ 1hour 10mi n	20mi n ~ 1hour 10mi n	#5802 (Manhole)	#5801 (Manhole)	<ul style="list-style-type: none"> Capacity of existing pump station is insufficiency
	<ul style="list-style-type: none"> Establishment of east and west rainwater pump station Additional establishment of east pipe channel(1000mm) 	-	-	-	-	-	-	



Conclusion

- Improvement of surface water – pipe channel integration model
 - ▶ Development of integrated inundation analysis model between surface water and sewage pipe channel using GIS
- Examination of flood inundation damage possibility on airport water distribution system
- When execute flood inundation analysis model, offer user's convenience by develop and present pre-post process using GIS.

DPSI
Thank you !!!

